FLOOD PLAIN MANAGEMENT STUDY
CITY OF HENRIETTA
AND
DRY FORK OF THE LITTLE WICHITA RIVER
CLAY COUNTY, TEXAS

PREPARED BY
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

IN COOPERATION WITH
LITTLE WICHITA SOIL AND WATER CONSERVATION DISTRICT
CLAY COUNTY COMMISSIONERS COURT
AND THE
CITY OF HENRIETTA

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INTRODUCTION

The assistance and cooperation given by the agencies, organizations, and individuals during the development of data leading to the Dry Fork of the Little Wichita River Flood Plain Management Study report is greatly appreciated. These include:

Little Wichita Soil and Water Conservation District
Clay County Commissioners Court
City of Henrietta

Special appreciation is extended to the individuals who contributed information for the study. Appreciation is also extended to the landowners who permitted access to their property for surveys, photographs, and reconnaissance.

The City of Henrietta has experienced private and public property damage as a result of flooding from Dry Fork. In an effort to obtain assistance in reducing flood damages, the local entities requested technical assistance from the Soil Conservation Service (SCS). Preapplication planning assistance was provided under Public Law 566. This assistance indicated a probable economically feasible project and an application for financial assistance was made to the Texas State Soil and Water Conservation Board. Preparatory to formally presenting this request to the Texas State Soil and Water Conservation Board and the setting of a planning priority for SCS to provide technical and financial assistance, the local agencies met with the landowners who would be directly affected by installation of project measures. After this meeting, the local organizations reassessed their responsibilities in the project and chose not to commit their resources and authorities to a Public Law 566 project at this time.

It was determined that the best means of making the valuable information developed during preapplication planning assistance available to the

local people is in a Flood Plain Management Study report that identifies areas subject to flooding by Dry Fork of the Little Wichita River.

The SCS conducts such cooperative flood plain management studies in Texas through the November 1973 Joint Coordination Agreement (Revised October 30, 1978) between the SCS and the Texas Department of Water Resources. SCS assists state agencies and communities in the development, revision, and implementation of their flood plain management programs by carrying out cooperative flood plain management studies (FPMS's) in accordance with Federal Level Recommendation 3 of "A Unified National Program for Flood Plain Management," and Section 6 of Public Law 83-566. The principles contained in Executive Order 11988, Flood Plain Management, are addressed in this report.

Topographic data for this study were obtained from field surveys and Geological Survey topographic maps. Rainfall frequency data were obtained from Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas of the United States." Peak discharge values were determined by flood routing various storm frequencies with a 24-hour rainfall duration using Technical Release No. 20, "A Computer Program for Project Formulation, Hydrology." Water surface profiles were developed by the Modified Slope Area Method using SCS Technical Release No. 61, "WSP2, A Computer Program for Determining Flood Elevations and Flood Areas for Certain Flow Rates."

The computed flood elevations in this report were determined using detailed study procedures and are considered reasonably accurate.

STUDY AREA DESCRIPTION

LOCATION AND SIZE

Dry Fork of the Little Wichita River watershed is located entirely within Clay County, Texas. The watershed has a total area of 50.09 square miles (32,000 acres), an overall length of about 14 miles, and a maximum width of about 5.5 miles. The watershed slopes from southwest to northeast at about 19 feet per mile. Dry Fork of the Little Wichita River heads approximately 13 miles south-southwest of Henrietta, flowing north and east through the southeast part of the city to its confluence with the Little Wichita River.

DEMOGRAPHIC DATA

The city of Henrietta, population 3,149, lies on the northern watershed divide. Clay County, population 9,582, is included within the Wichita Falls SMSA, which has a population of 130,664 (U.S. Department of Commerce, Bureau of the Census).

The following table shows the demographic data for Henrietta and Clay County and is representative of the watershed:

Demographic Data[1]

	Henrietta	Clay County
1980 Population	3,149	9,544
Race - White	3,082	9,439
Black	58	67
Other	9	38
Spanish Origin[2]	5	38
1980 Housing Units	1,370	4,386

[1]U.S. Department of Commerce, Bureau of the Census: 1980 Census of Population and Housing (Advance Reports).

[2]Spanish origin included in white.

Agricultural Census Data

Clay County:

Number of Farms	825
Farms with Sales over $20,000	231
Farms with Sales Less than $20,000	594
Percent Small Farms	72%

U.S. Agricultural Census, 1978

CLIMATE

Clay County has a warm-temperate, subhumid climate with hot summers. The average date of the last killing frost in the spring is March 27, and that of the first killing frost in the fall is November 14, resulting in an average growing season of 232 days (Texas Almanac and State Industrial Guide, 1978-1979, A. H. Belo Corporation, Dallas, Texas).

The average annual precipitation is 31.40 inches. Of this, an average of 20 inches, or 64 percent, falls from April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall from April through September is less than 15 inches. The heaviest 1-day rainfall recorded at the Henrietta gage was 6.07 inches on June 23, 1959. Higher rainfall events have occurred on the watershed for longer durations; one recent example is the October 12-13, 1981 event. The rainfall ranged from 12.5 inches in the upper portion of the watershed to 7.5 inches at Henrietta during a 32-hour period.

GEOLOGY

Geologic outcrops in the watershed are Permian mudstone and sandstone and Recent flood plain deposits. The predominant mudstone is of the

redbed facies and contains minor amounts of sand and gravel. The sand content is greater in the western third of the watershed, as manifested by the relatively coarser grained soils in the area. Sandstone outcrops are dominantly fine-grained, cross-bedded, argillaceous channel-fill deposits. Channel-fill deposits are localized, but are evident throughout the watershed in road bank cuts. Faults or joints were not observed in any of these strata. Recent flood plain deposits are comprised of clay, silt, sand, and gravel. The dominant material, depending on location, ranges from clay to sand with gravel present as a minor fraction.

SOILS

The watershed is in the North Central Prairies Land Resource Area. The soils are mostly deep and moderately deep loams and clays. Scattered areas of hilly, stony soils occur on breaks adjacent to the drainageways. Small areas of sandy soils occur in the southern part of the watershed. The land surface is nearly level to hilly. The drainage is mainly toward the northeast into the Little Wichita River.

The major soil series occurring in the watershed are Bluegrove, Stoneburg, Bonti, Windthorst, Kamay, Renfrow, Waurika, Stephenville, and Port. For a detailed description of the soils in Clay County, see the "Soil Survey of Clay County, Texas."

LAND USE

There are 64 farms or ranches, averaging about 500 acres in size, in the watershed. Land in the watershed is mainly (98 percent) in private ownership, with the state, county, or city owning the other 2 percent.

The land use is shown in the following table:

Estimated Land Use in the Watershed

Land Use	Flood Plain[1] (acres)	Upland (acres)	Total (acres)
Cropland	200	3,100	3,300
Pastureland	200	1,200	1,400
Rangeland	118	25,082	25,200
Other[2]	250	1,850	2,100
TOTAL	768	31,232	32,000

[1]Evaluated 100-year flood plain
[2]Roads, railroads, urban, and suburban areas

An effective conservation program based on the use of each acre within its capabilities and its treatment in accordance with its needs for protection and improvement is now being carried out by the Little Wichita Soil and Water Conservation District. Owners or operators of 51 of the 64 farm or ranch units in the watershed are cooperating with the SWCD. It is estimated that 70 percent of the watershed is adequately protected from erosion and that 60 percent of the planned conservation practices have been applied.

NATURAL VALUES

PLANT AND ANIMAL RESOURCES

The watershed is in the Cross Timbers and Prairies vegetational area of Texas. In spite of the wide variation in soils, the climax understory vegetation is rather uniform. The predominant grasses are little bluestem; Indiangrass; switchgrass; Canada wildrye; sideoats, hairy, and blue grama; and Texas wintergrass. The better soils are under cultivation (forage sorghum and cool-season small grains) and there are many areas of perennial pasture. Mesquite has invaded the upland, along

with low-value annual and perennial grasses and forbs. Woody species such as hackberry, Siberian elm, and pecan are found along watercourses.

Major game animals in the watershed are mourning dove and bobwhite quail. Other species present include cottontail rabbit, fox squirrel, armadillo, opossum, and various species of songbirds, raptors, reptiles, and amphibians. Furbearers such as skunk, coyote, fox, and raccoon are present.

There are no known threatened or endangered species of plants or animals in the watershed. There are no areas of critical habitat designated in the vicinity.

Most species of wildlife in the watershed depend on the presence of the woody vegetation that exists along watercourses. This woody vegetation is used for food and cover for nesting and travelways. The woody vegetation is almost a continuous strip and is deemed necessary for existence of several of the common species.

HISTORICAL SITES

The watershed has no known historical sites as recognized by the U.S. Department of the Interior, Heritage and Recreation Service.

ECONOMIC RESOURCES

The economy within the area relies primarily upon oil, agribusiness, and varied manufacturing. In 1981, the agricultural production for Clay County was $42 million, mainly from livestock and small grain production. Clay and Wichita Counties comprise the Wichita Falls Standard Metropolitan Statistical Area, which is the hub of a petroleum and agricultural producing region in northern Texas and southern Oklahoma.

FLOOD PROBLEMS

Floodwater damages residences, commercial properties, streets, roads, bridges, and railroad facilities, and interrupts normal traffic patterns. The depth and velocity of floodwater in this watershed is an apparent threat to the lives of persons living in or traveling through the watershed. Floodwater also creates potential health hazards, provides vector habitat, and causes many inconveniences that tend to lower the quality of life.

When the floodwaters recede, channels are laden with debris consisting of uprooted brush and small trees, fence wire, and other trash. This reduces the capacity of the channel and bridge openings, which increases the flood potential and endangers the bridges.

The area inundated by various frequency flood events is shown in the following table:

Area Inundated by Floodwater

10 percent chance	= 680 acres
4 percent chance	= 720 acres
2 percent chance	= 740 acres
1 percent chance	= 768 acres
.2 percent chance	= 821 acres

Major floods occur on an average of every 10 years. Individual accounts and stream gage records indicate that recent major floods occurred in 1941, 1947, 1954, 1972, and 1981. The most recent flood occurred in October 1981. As a result of this flood, 27 residential properties were inundated, causing estimated monetary damages of $540,810, and 10 commercial properties were flooded, resulting in damages of $1,115,770

and unemployment of 200 workers for about one week. In addition, crop and pasture damages were estimated to be $12,460.

In 1972, a storm of lesser magnitude, approximating a 7 percent chance of occurrence, caused considerable damage. Extensive damage occurred to the Fort Worth and Denver Railroad crossing of Dry Fork when a mobile home was carried by floodwater and lodged in the bridge opening. This caused a breach in the bridge abutment and, consequently, interrupted the railroad traffic several days. The abutment was repaired to its original condition, allowing the possibility of this occurring again as the bridge is frequently overtopped by flood flows.

Flooding on agricultural lands damages crops and pastures, fences, and other farm improvements. Flood plain scour and streambank erosion are minor.

The following tabulation shows the numbers of residences and commercial buildings which are damaged by various storm events and the depth of floodwater within the homes or buildings:

Residential and Commercial Properties Flooded by Storm Events

	Frequency[1] (percent)	Buildings Flooded (number)	Maximum Depth of Floodwater Inside Building (feet)
Residential	1.0	27	6.4
	2.0	19	5.2
	4.0	14	4.3
	10.0	8	2.8
	20.0	6	2.0
	50.0	2	0.4
	100.0	0	.0
Commercial	1.0	10	6.7
	2.0	10	5.6
	4.0	9	4.6
	10.0	8	2.6
	20.0	7	1.6
	50.0	2	0.1
	100.0	0	.0
Total	1.0	37	6.7
	2.0	29	5.6
	4.0	23	4.6
	10.0	16	2.8
	20.0	13	2.0
	50.0	4	0.4
	100.0	0	.0

[1]Annual chance of occurrence in percent.

ECONOMIC AND SOCIAL PROBLEMS

Residents of the watershed who live on flood-prone land suffer losses that lower their standard of living. The constant threat of damaging floodwater creates anxiety and emotional stress. Monetary losses, apparent risk of loss of life, and displacement from homes and business are major problems. Other major problems are the control of vectors and the cleanup of debris which is spread throughout the flood plain by floodwaters.

The constant threat of flooding has lowered the capital value of real property in the flood plain. A direct effect is the suppression of the property tax base within Henrietta and Clay County, resulting in less funds being available for municipal and county operations and improvement.

Casualty losses directly related to flood damages have caused a loss of federal income tax revenue. Loss of personal income and purchasing power while businesses are shut down due to flooding and its after effects is also a loss of sales tax and income tax revenue.

The repair of flood-related road and bridge damage is a perennial drain of governmental funds and denies the use of these obligated funds for other constructive uses.

As a result of the 1981 flood, local authorities requested and received assistance from the Small Business Administration. Low interest loans were made available to the flood victims who qualified for assistance under this program authority.

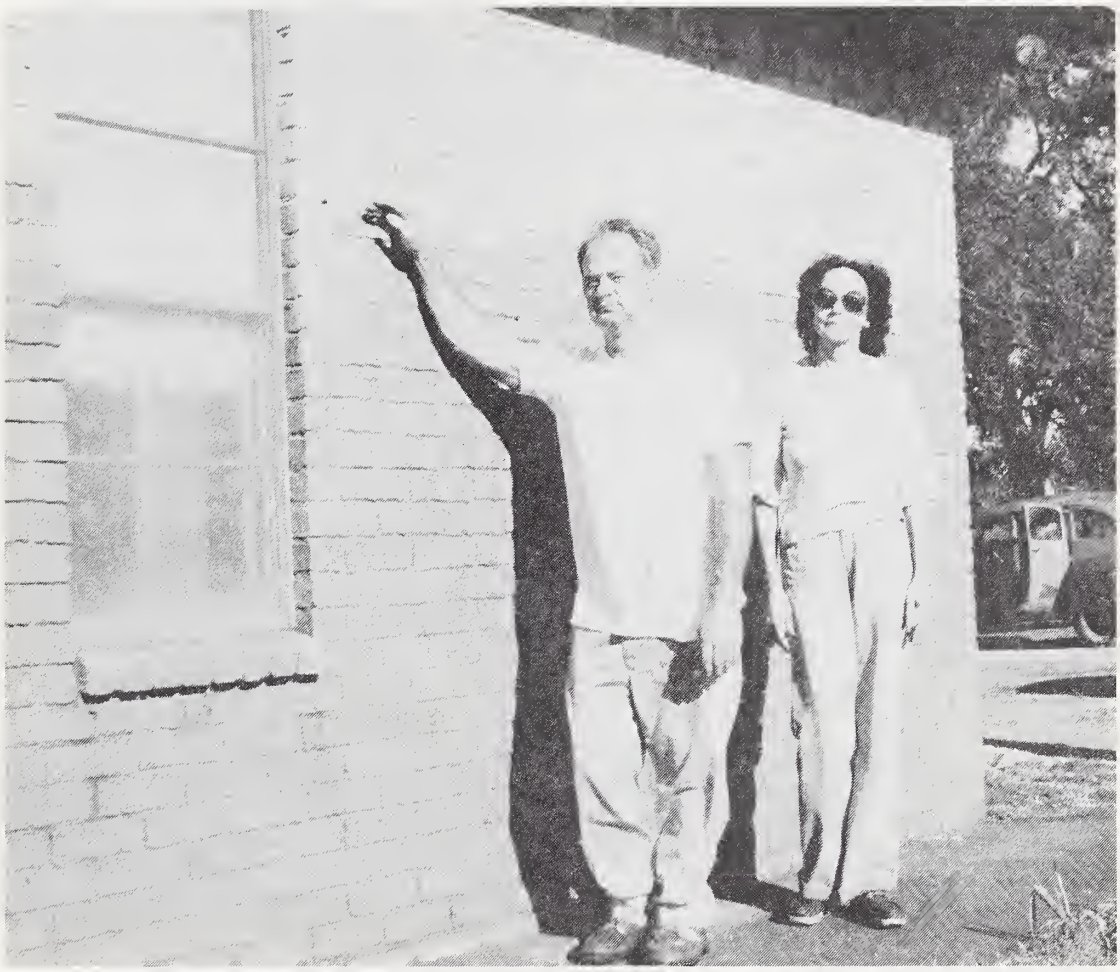
Photographs on the following pages depict the flood problems of the October 1981 flood. The photographs are used through the courtesy of the "Clay County Reader."

EXISTING FLOOD PLAIN MANAGEMENT

The 61st Texas Legislature in 1969 enacted the Texas Flood Control and Insurance Act, Article 8280-13 VACS, and Article 1581e-1 VACS. Article 8280-13 named the Texas Water Development Board and the State Board of Insurance as the responsible state level agencies in respect to the National Flood Insurance Program. In 1977, the 65th Texas Legislature merged the state's three existing water agencies into the Texas Department of Water Resources. Article 8280-13 was codified in the Texas Water Code (Subchapter I, Section 16.311), and responsibility for the flood insurance program in Texas was assigned to the Texas Department of Water Resources and the State Board of Insurance. Subchapter I, Section 16.315 of the Code authorizes all political subdivisions, including cities, counties, and many types of special purpose districts and authorities to take all necessary and reasonable actions to comply with the requirements and criteria of the National Flood Insurance Program.

At the present time, state level statutory controls on use and management of flood hazard areas are fairly limited. Subchapter G, Section 16.238 of the Texas Water Code requires the Texas Department of Water Resources to approve plans for any levee or other such improvement which may change flood flows of any stream in Texas that is subject to floods. Also, in December 1977, Governor Dolph Briscoe issued Executive Order No. 34-A calling for state agencies to implement a flood plain management program for state-owned property and facilities. This state program will utilize state agency rules and regulations calling for evaluation of flood hazards and will conform to the minimum flood plain management criteria established by the U.S. Department of Housing and Urban Development for the National Flood Insurance Program.

Prior to this flood plain management study, the local governmental entities did not have factual flood hazard area maps. The flood-prone



Flood victims point to high water marks left by floodwaters that inundated their home south of Henrietta on Texas 148 on Tuesday morning, October 13, 1981. This photograph was taken October 14, 1981, as these and other victims tackled the task of cleaning debris and assessing damage left by the swollen waters of Dry Fork.

In October 1981, this home and 26 other residential properties were flooded. The constant threat of damaging floodwater creates anxiety, emotional stress, and monetary losses. The depth and velocity of floodwater in this watershed is an apparent threat to the lives of persons living in or traveling through the watershed.

This section of the Fort Worth and Denver Railroad was uprooted by debris and floodwaters that inundated southern Henrietta Tuesday morning, October 13, 1981. This damage interrupted the railroad traffic for several days.

Driveway to a service station south of Henrietta was uprooted by floodwaters of Dry Fork on Tuesday, October 13, 1981. Large pieces of asphalt were literally floated away by rushing waters.

Floodwater damages residences, commercial properties, streets, roads, and bridges, and interrupts normal traffic patterns.

area maps available were prepared by approximate methods and the local governmental entities did not consider them sufficiently accurate for flood plain management purposes.

The Federal Flood Insurance Program has recently been made available for residents of flood-prone real property in the watershed. It was available to residents of Henrietta but not Clay County during the 1981 major flood. However, only one known victim of that flood was insured under the flood insurance program. In the past few months, the program has been expanded to Clay County residents and has been widely accepted according to the local program coordinator.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

PRESENT CONDITIONS

Since flood hazard area maps have not been available prior to this study, the flood plain has been developed with very little regard to possible future flood damage.

LAND TREATMENT

Effective conservation land treatment is presently being carried out by landowners and operators in the watershed. Excess runoff, erosion, and sedimentation due to lack of conservation land treatment are not major causes of flooding.

PRESERVATION AND RESTORATION OF NATURAL VALUES

Since the primary natural value of the flood plain is its ability to transport floodwaters, encroachment onto the flood hazard areas of the flood plain with obstacles which interfere with the movement of floodwater should be avoided to preserve its present carrying capacity.

NONSTRUCTURAL MEASURES

Nonstructural measures which will help reduce or minimize flood losses include flood proofing, flood warning systems, relocations, zoning regulations, participation in the national flood insurance program, emergency preparedness, and building or development codes.

Flood proofing can reduce flood damages by a combination of structural provisions and changes or adjustments to properties subject to flooding. Examples of flood proofing are sealing low window and door openings and modifying floor drains to prevent the entrance of floodwaters.

Flood warning systems should be coordinated with local disaster plans. The National Weather Service issues warnings of potential flood producing storms. Staff gages set at key locations can be monitored to give advance warnings. A float-activated electronic signal could be connected to the local police or fire station for monitoring.

Relocation involves permanent evacuation of developed areas subject to inundation, acquisition of lands by purchase, removal of improvements, and relocation of the population from such areas. Such lands could be used for parks or other purposes that would not suffer large flood damages and would not interfere with flood flows.

Zoning is a legal method used to implement and enforce the details of the flood plain management program, to preserve property values, and to achieve the most appropriate and beneficial use of available land. Clear, concise, and thorough zoning bylaws with enforcement of the bylaws are essential to make zoning effective.

Flood insurance was established by the Nationl Flood Insurance Act of 1968 (Public Law 90-448, as amended) to make limited amounts of flood insurance, which was previously unavailable from private insurers, available to property owners and occupiers. The Flood Disaster

Protection Act of 1973 (Public Law 93-234, as amended) was a major expansion of the National Flood Insurance Program.

Flood insurance is available through local insurance agents and brokers.

The City of Henrietta and Clay County are participating in the National Flood Insurance Program.

Emergency preparedness consists of a plan by local officials to be put into effect in the event of flooding. Procedures are worked out and personnel designated to implement the plan. Methods and procedures to alert and warn the populace of possible flooding are developed. High risk areas and handicapped, elderly or others known to need help during evacuation are located and identified. Plans are made for their evacuation or rescue. Shelters are provided for evacuees.

Building codes are developed to set up minimum standards for controlling the design, construction, and quality of materials used in buildings and structures within a given area to provide safety for life, health, property and public welfare. Building codes can be used to minimize structural and subsequent damages resulting from inundation. Building restriction codes can:

1. Specify adequate anchorage to prevent flotation of buildings from their foundations.

2. Establish basement elevations and minimum first-floor elevations in accordance with potential flood heights.

3. Prevent virtually all damage by elevating the foundation and prohibiting basements in those areas subject to very shallow and frequent flooding.

4. Require building reinforcement to withstand water pressure or high velocity flow and restrict the use of materials which deteriorate rapidly in the presence of water.

5. Prohibit equipment that might be hazardous to life when submerged. This includes chemical storage, boilers, and electrical equipment.

Development policies which are designed to prevent construction of streets and utility systems in flood-prone areas tend to slow development of the flood plain.

STRUCTURAL MEASURES

At the request of the local entities, the SCS provided assistance in determining alternative solutions to the flood problems. Structural measures such as dikes and channels did not appear to be viable alternatives due to site conditions and existing roads and buildings. The alternative which was recommended was the installation of one floodwater retarding structure.

Installation of the floodwater retarding structure would prevent flooding from the 100-year frequency flood originating from the Dry Fork of the Little Wichita River to all but one existing urban property in the watershed. It would leave no apparent risk of loss of life in any building in the flood hazard area from the 100-year storm event. It would directly benefit 56 owners and operators in the flood plain. Average annual flooding would be reduced from 687 acres to 133 acres, an 81 percent reduction.

The 500-year flood plain without-project conditions consists of approximately 821 acres, 280 acres of which are of urban and built-up land. With the project, the 500-year flood plain will consist of approximately 677 acres, of which 230 acres are urban and built-up land.

MAPS AND TABLES

The index map, flood hazard area photo maps and flood profiles are included in the technical appendix. The index map shows the study area coverage of individual flood hazard area maps and the watershed boundaries.

The limits of the 100-year and 500-year frequency floods, for present conditions, were delineated on aerial photographs (Technical Appendix, Flood Hazard Area, Sheets 1 through 3) to indicate the extent of area inundated. The 10-year and 50-year frequency floods for present conditions could not be effectively shown on the aerial photographs due to the map scale and topography. The flood lines shown are based on field surveys of roads, bridges, and valley sections used in conjunction with Geological Survey topographic maps having 10-foot contour intervals, and interpretation of aerial photographs. These maps should only be used to determine the approximate boundaries of the flood areas. Actual dimensions measured on the ground may vary slightly from those measured on the photo maps of this report due to map scale and reproduction limitations. The water surface profile elevations should be used to determine actual on-the-ground dimensions.

Flood elevations in this report are minimum elevations. Debris may collect at bridges and culverts and clog the channels during major floods and increase the depth of flooding. Analyses were made without showing the effects of potential obstructions. Also, extremely rare events such as catastrophic storms were not analyzed.

The water surface profiles show the profiles of the 10-year, 50-year, 100-year and 500-year frequency floods for present conditions. Included on the profiles are stream elevations of the channel bottom, pertinent bridge and roadway data, and other location data. The profile stationing is in terms of stream distance in feet and is based upon high channel flow distances. Flood depths can be estimated at any location

on the stream reach from the water surface profiles. (See "Water Surface Profiles," Sheets 1 through 4, Technical Appendix.)

Cross sections, representative of the streams studied, have been plotted to illustrate the shape of that stream and its flood plain. The 10-year, 50-year, 100-year, and 500-year floodwater surface elevations are shown on each of the plotted cross sections to illustrate the effect of various flood depths. (See Technical Appendix, "Typical Valley Cross Sections.")

The elevations, discharges, and flood plain width of the 10-year, 50-year, 100-year, and 500-year floods at surveyed cross sections are shown in the Appendix, Table 1. Each cross section is listed by number on this table. Each cross section is also identified by number on the flood hazard area photo maps. Identify cross section of interest on the photo map, then turn to Table 1 and read the discharge, elevation, and flood plain width directly from the table.

Also included in the appendix is a list of elevation reference marks showing the elevation and location of each (Table 2). Additional data are on file in the USDA Soil Conservation Service State Office, W. R. Poage Federal Building, 101 South Main Street, Temple, Texas 76501-7682.

GLOSSARY

Channel - A natural stream that conveys water; a ditch or channel excavated for the flow of water.

Channel Bottom - The elevation of the deepest part of a stream channel at a particular cross section.

Flood - An overflow or inundation that comes from a river or other body of water and causes or threatens damage.

Flood Frequency - A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative streamflow or rainfall and runoff records. A 10-year frequency flood would have an average frequency of occurrence in the order of once in 10 years (a 10 percent chance of being equalled or exceeded in any given year). A 50-year frequency flood would have an average frequency of in the order of once in 50 years (a 2 percent chance of being equalled or excceded in any given year). A 500-year frequency flood would have an average frequency of occurrence in the order of once in 500 years (a 0.2 percent chance of being equalled or exceeded in any given year).

Flood Peak - The highest value of the stage or discharge attained by a flood; thus, peak stage or peak discharge.

Flood Plain - (1) Nearly level land situated on either or both sides of a channel which is subject to overflow flooding. 2. Lowland and relatively flat alluvial areas adjoining inland and coastal waters (streams, bays, etc.), including flood-prone areas of offshore islands.

500-Year Flood Plain - The land that would be flooded on an average of once every 500 years.

100-Year Flood Plain - The land that would be flooded on an average of once every 100 years.

Flood Profile - A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage - The stage at which overflow of the natural banks of a stream begins to cause damage in the reach in which the elevation is measured.

High Water Mark (HWM) - The maximum observed and recorded height or elevation that floodwater reaches during a storm, usually associated with the flood peak. The high water mark may be referenced to a particular building, bridge, or other landmark, or based on debris deposits on bridges or fences, or other evidence of the flood.

Low Bank - The highest elevation of a specific channel cross section at which the water will be contained without overflowing onto adjacent flood plain areas.

Runoff - That portion of the precipitation on a drainage area that is discharged from the area in stream channels; types include surface runoff, groundwater runoff, or seepage.

Structural Bottom of Opening - The lowest point of a culvert or bridge opening with a constructed bottom through which a stream flows that could tend to limit the stream channel bottom to that specific elevation. This structural bottom may be covered with sediment or debris which further restricts the size of the opening.

Top of Opening - The lowest point of a bridge, culvert, or other structure over a river, stream or watercourse that limits the height of the opening through which water flows. This is referred to as "low steel" or "low chord" in some regions.

Water Surface Profile - A graph showing the relationship of water surface elevation to stream channel location for a specific flood event.

Watershed - All land and water within the confines of a drainage divide.

Watershed Boundary - The divide separating one drainage basin from another.

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APPENDIX

TECHNICAL APPENDIX

This is the Technical Appendix to the Dry Fork of Little Wichita River Flood Plain Management Study report. It is a compilation of the FPMS technical findings. It includes the photo map index, flood hazard area photo maps, flood profiles, plottings of typical stream channel cross sections, elevation and discharge tabulations, and a listing of pertinent elevation reference marks. Other technical data developed during this study is on file in the USDA Soil Conservation Service State Office, W. R. Poage Federal Building, 101 South Main Street, Temple, Texas 76501-7682.

INVESTIGATIONS AND ANALYSES

FIELD SURVEYS

Topographic data were obtained from Geological Survey topographic maps and field surveys. Engineering surveys were made of cross sections selected to represent the stream hydraulics and flood plain areas (refer to the typical valley cross sections). Elevations appearing in this report are based on permanent elevation reference marks established by the Coast and Geodectic Survey in 1932. These permanent elevation reference marks were based on mean sea level (m.s.l.) data. Temporary elevation reference marks were established by the SCS in 1982. Table 2 of the Appendix shows the listings, descriptions, and locations of permanent and temporary elevation reference marks.

HYDROLOGIC AND HYDRAULIC METHODS

The Dry Fork of the Little Wichita river watershed boundaries were determined by use of Geological Survey topographic maps. The top of the watershed begins approximately 12.0 miles south of the Henrietta city limits in Clay County. Hydraulic evaluations were based on synthetic frequency methods. Rainfall frequency data were obtained from Weather

Bureau Technical Paper No. 40, "Rainfall Frequency Atlas of the United States." Values greater than the 100-year frequency event were determined by extrapoloation of the rainfall versus frequency graph. Peak discharge values were determined by flood routing various storm frequencies with a 24-hour rainfall duration using SCS Technical Release No. 20, "A Computer Program for Project Formulation, Hydrology." The program computes surface runoff resulting from any synthetic or natural rainstorm. The program will route the flow through stream channels and reservoirs. Results include, but are not limited to, a combination of the routed hydrograph with those from other tributaries and a printout of the peak discharges, their time of occurrence, and the water surface elevations for each computed discharge at any desired cross section or structure.

Historic flood data from gaged streams in the vicinity of the Dry Fork of the Little Wichita River are limited to watersheds with much larger drainage areas. The nearest gage having very similar runoff characteristics and climatic conditions is the East Fork of the Little Wichita River with a total drainage of 178 square miles. A peak flow analysis of this gage was conducted using WRC Bulletin 17B and transposed onto the Dry Fork of the Little Wichita River watershed with adjustments for the drainage area. The results indicated that the 100-year frequency discharge determined by the flood routings correlate well with the stream gage analysis.

Geological Survey Water Resources Investigations 77-110 Open-File Report,"Technique for Estimating the Magnitude and Frequency of Floods in Texas" does not apply to the part of Texas where the Dry Fork of the Little Wichita River watershed is located, so no comparison of peak discharges obtained by this method was made.

From the representative stream and road cross sections, water surface profiles were developed by the Modified Slope Area Method. The effects of bridges and culverts on the stream hydraulics were determined by use

of the Bureau of Public Roads (BPR) Method. Computations were made using SCS's "WSP2, A Computer Program for Determining Flood Elevations and Flood Areas for Certain Flow Rates." Using the output data from this program, rating curves were plotted for each cross section. These curves show the relationship between stage or elevation and discharge. Water surface profiles were developed from these rating curves and the computer results of TR-20 routings.

FLOOD HAZARD EVALUATION

The 500-year and 100-year frequency flood hazard areas are outlined on aerial photographs obtained from the June 1978 Geological Survey flight. The flood hazard area boundaries were developed by plotting the computed water surface elevations on the surveyed cross sections and transposing this information to the aerial photographs. The flood hazard areas between the surveyed cross sections were developed through interpretation of Geological Survey topographic maps and the aerial photographs in conjunction with the surveyed cross sections. Actual flood limits may vary slightly on the ground from the outlined area on the photo maps due to map scale and reproduction limitations. For this reason, the water surface elevations from the flood profiles should be used for determining site specific potential flood depths.

ESTIMATES OF FLOOD LOSSES

First floor elevations of buildings located within the flood hazard areas were determined using survey instruments. The first floor elevations were compared to the computed potential floodwater surface elevations. Potential flood depths for the various flood frequency events were determined and estimates made of the resulting damages.

INVENTORY OF NATURAL VALUES

The natural values of the Dry Fork of the Little Wichita River flood plain were determined by the SCS staff biologist through on-the-ground reconnaissance, interviews of local people, and literature search.

PUBLIC PARTICIPATION

The Dry Fork of the Little Wichita River Flood Plain Management Study Plan of Work was developed through consultation with the local officials and study endorsers.

A public meeting was held during preapplication planning assistance under Public Law 566 in order to get public input and participation.

MANAGEMENT ALTERNATIVES

Nonstructural management alternatives were considered during the flood plain management study and discussed during meetings with local public officials and other interested members of the public. Alternatives considered to have merit and worthy of further study for possible implementation were put in the report.

LEGEND

- COUNTY LINE
- RAILROAD
- DIVIDED HIGHWAY
- STATE HIGHWAY
- FARM TO MARKET ROAD
- WATERSHED BOUNDARY
- FLOOD HAZARD STUDY AREA
- 3 PHOTOMAP COVERAGE

INDEX MAP

FLOOD PLAIN MANAGEMENT STUDY AREA

DRY FORK OF LITTLE WICHITA RIVER
CLAY COUNTY, TEXAS

0 1 2 3 MILES

0 1 2 3 4 KILOMETERS

Approximate Scale

Source: County Highway Map
Polyconic Projection North American Datum
Control; U.S. Coast and Geodetic Survey
and U.S. Geological Survey

JULY 1984 4-R-38823

VICINITY MAP

INDEX MAP

FLOOD PLAIN MANAGEMENT STUDY AREA

DRY FORK OF LITTLE WICHITA RIVER CLAY COUNTY, TEXAS

0 1 2 3 MILES

0 1 2 3 4 KILOMETERS

Approximate Scale

Source: County Highway Map
Polyconic Projection North American Datum
Control; U.S. Coast and Geodetic Survey
and U.S. Geological Survey

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USDA-SCS-FORT WORTH, TEXAS 1984

LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Cross Section Location
- Stream Channel
- X Elevation Reference Marks
- 1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 500 1000 FEET
0 100 200 300 METERS
APPROXIMATE

USGS Photography 6-78

SHEET 1 OF 3

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
CLAY COUNTY, TEXAS

FLOOD HAZARD AREA

DRY FORK OF THE LITTLE WICHITA RIVER

JULY 1984 4-R-38824

LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Cross Section Location
- Stream Channel
- X Elevation Reference Marks
- 1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 500 1000 FEET
0 100 200 300 METERS
APPROXIMATE

USGS Photography 6-78

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DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
CLAY COUNTY, TEXAS

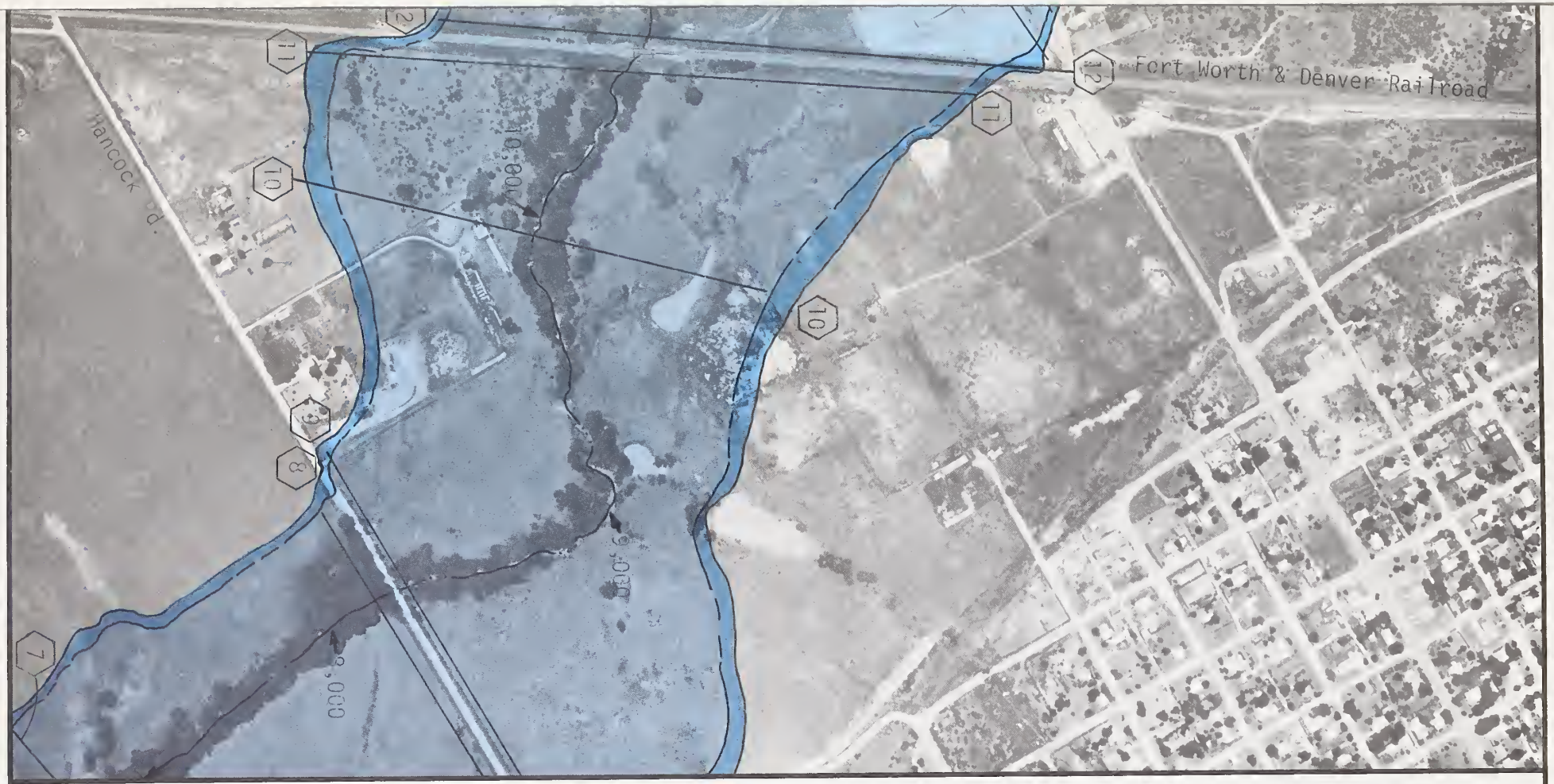
SHEET 1 OF 3

FLOOD HAZARD AREA

DRY FORK OF THE LITTLE WICHITA RIVER

USDA SCS FORT WORTH, TEXAS 1985

JULY 1984 4-R 38824



LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Cross Section Location
- Stream Channel
- X — Elevation Reference Marks
- 1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 500 1000 FEET
0 100 200 300 METERS
APPROXIMATE

USGS Photography 6-78

SHEET 2 OF 3

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
CLAY COUNTY, TEXAS

FLOOD HAZARD AREA

DRY FORK OF THE LITTLE WICHITA RIVER

JULY 1984 4-R-38824

LEGEND

100 Year Flood Hazard Area

500 Year Flood Hazard Area

Cross Section Location

Stream Channel

X Elevation Reference Marks

1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 500 1000 FEET

0 100 200 300 METERS

APPROXIMATE

USGS Photography 6-78

SHEET 2 OF 3

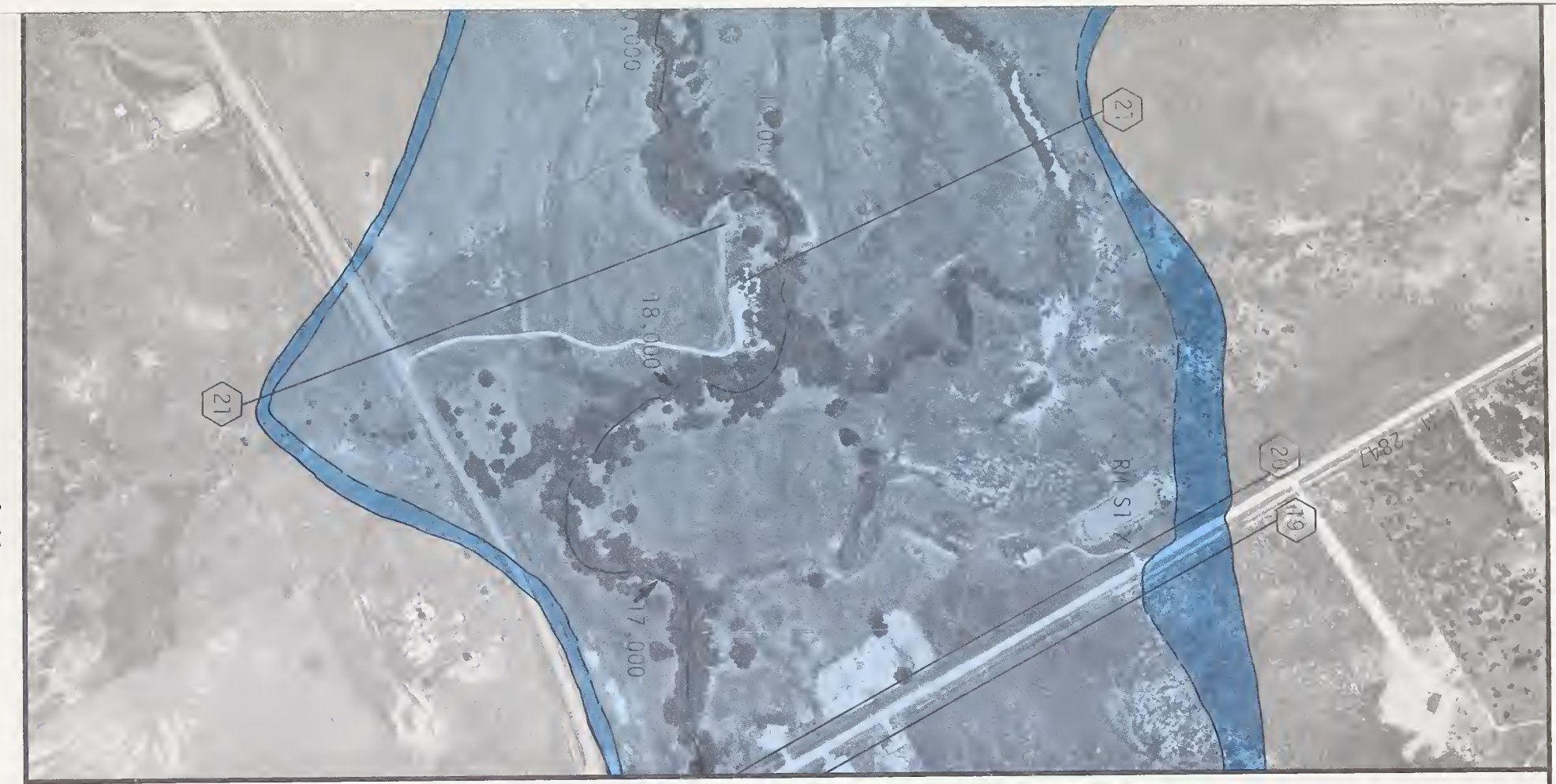
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
CLAY COUNTY, TEXAS

FLOOD HAZARD AREA

DRY FORK OF THE LITTLE WICHITA RIVER

USDA SCS-FORT WORTH, TEXAS 1985

JULY 1984 4-R-38824



LEGEND

100 Year Flood Hazard Area

500 Year Flood Hazard Area

Cross Section Location

Stream Channel

X Elevation Reference Marks

1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 500 1000 FEET

0 100 200 300 METERS

APPROXIMATE

USGS Photography 6-78

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
CLAY COUNTY, TEXAS

SHEET 3 OF 3

FLOOD HAZARD AREA

DRY FORK OF THE LITTLE WICHITA RIVER

JULY 1984 4-R-38824

LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Cross Section Location
- Stream Channel
- X Elevation Reference Marks
- 1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 500 1000 FEET
0 100 200 300 METERS
APPROXIMATE

USGS Photography 6-78

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SOIL CONSERVATION SERVICE
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
CLAY COUNTY, TEXAS

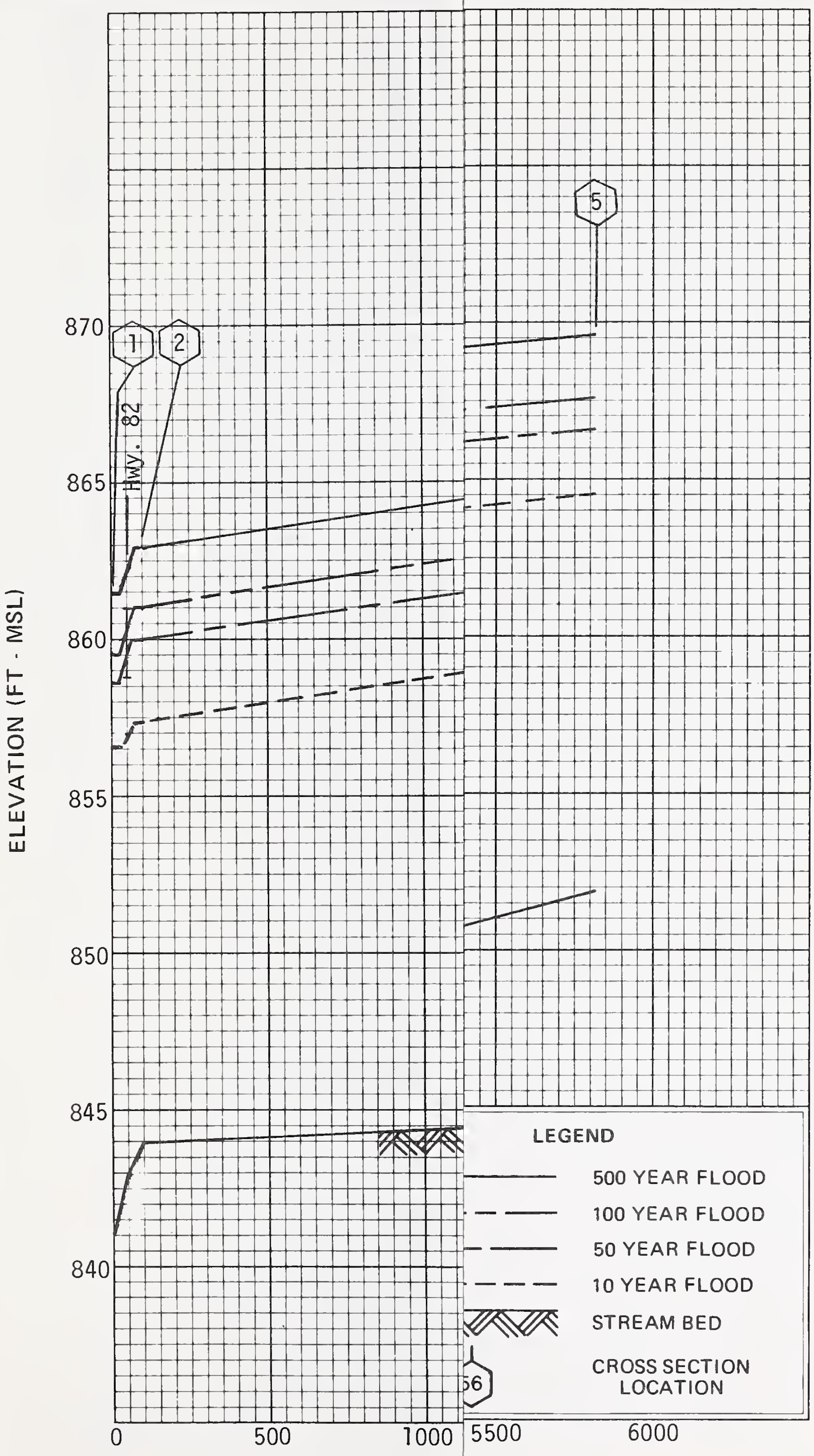
SHEET 3 OF 3

FLOOD HAZARD AREA

DRY FORK OF THE LITTLE WICHITA RIVER

USDA SCS FORT WORTH, TEXAS 1985

JULY 1984 4-R 38824

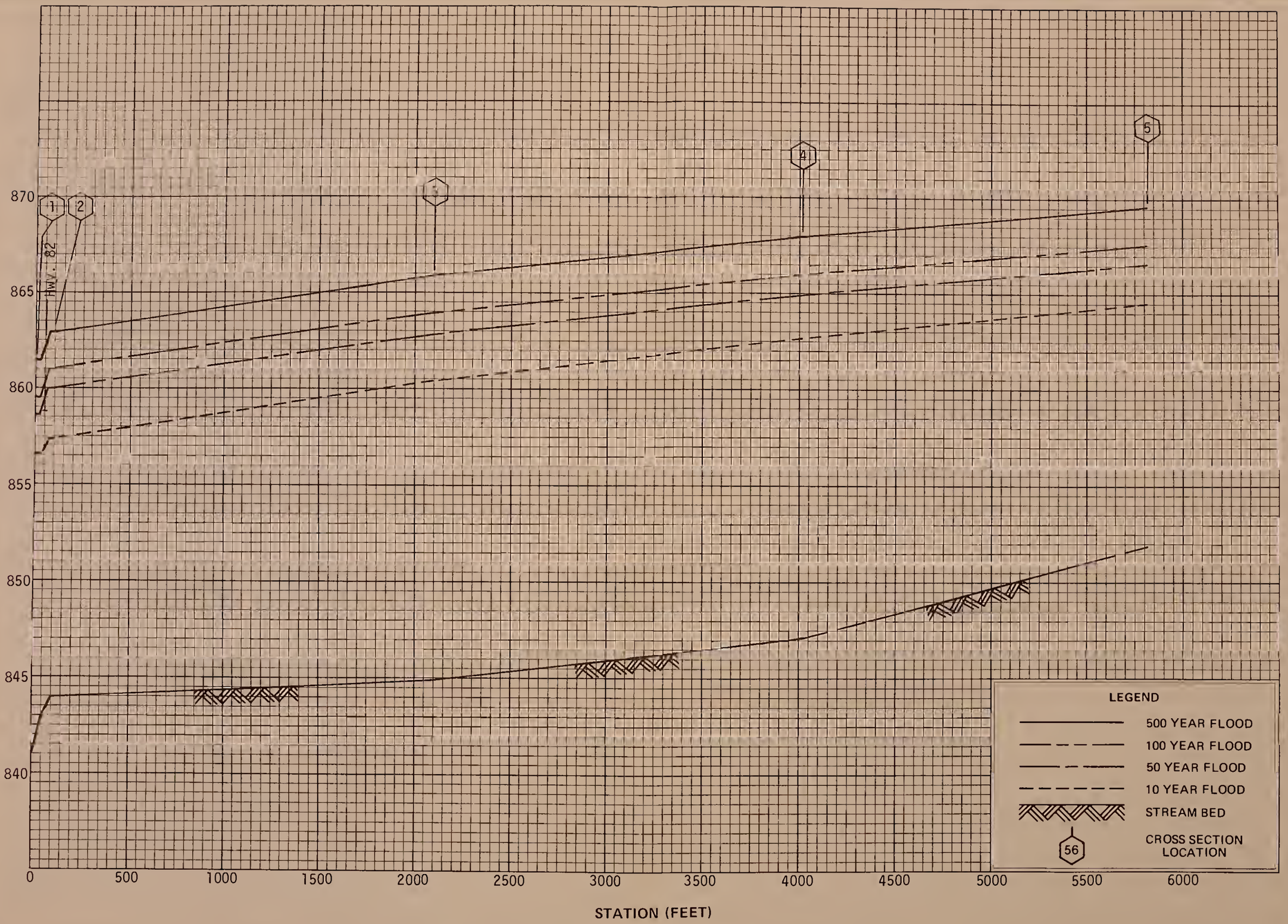


WATER SURFACE PROFILES

DRY FORK OF THE LITTLE WICHITA RIVER

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
Clay County, Texas

SHEET 1 OF 4

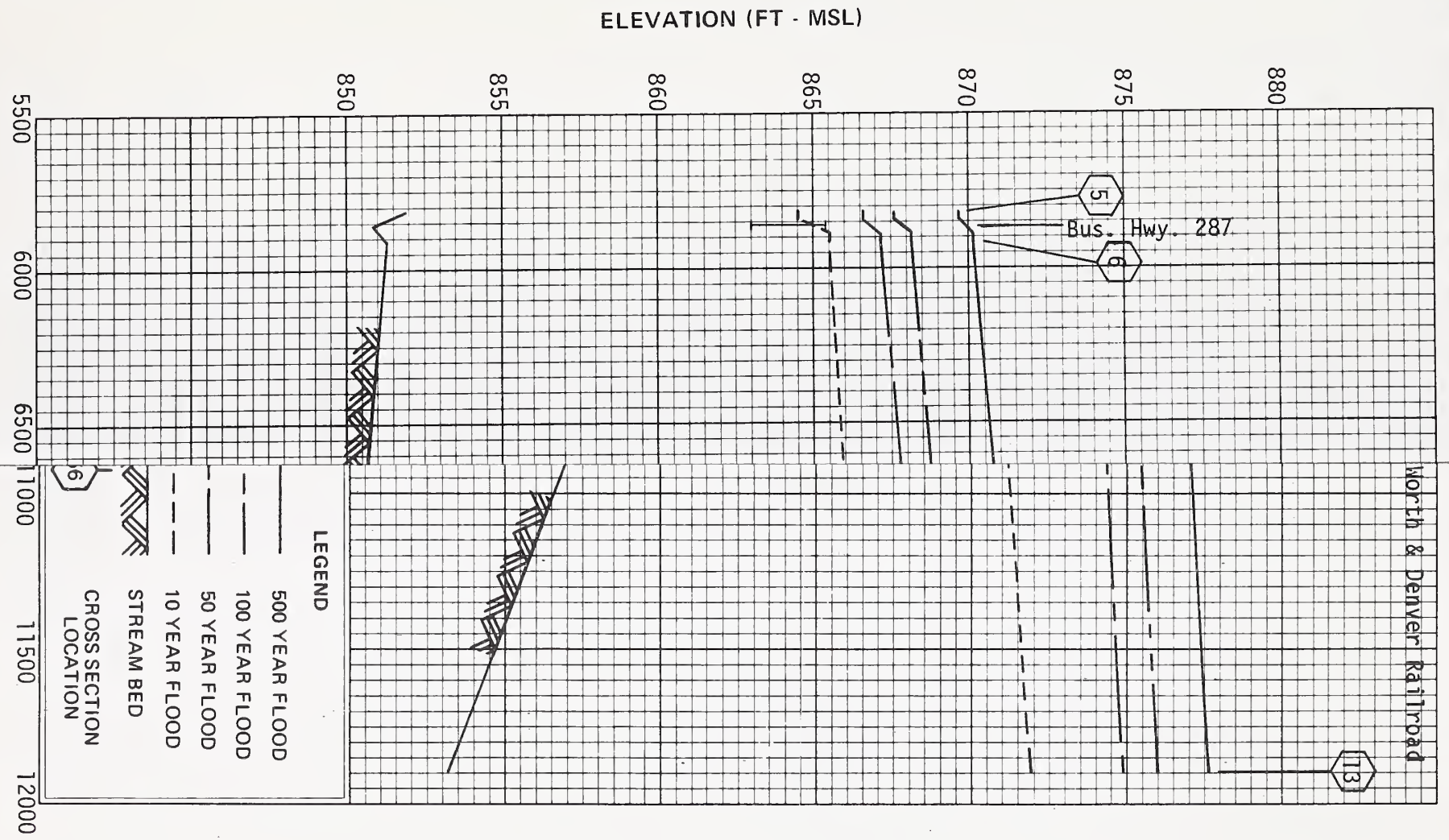


WATER SURFACE PROFILES

DRY FORK OF THE LITTLE WICHITA RIVER

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
Clay County, Texas

SHEET 1 OF 4



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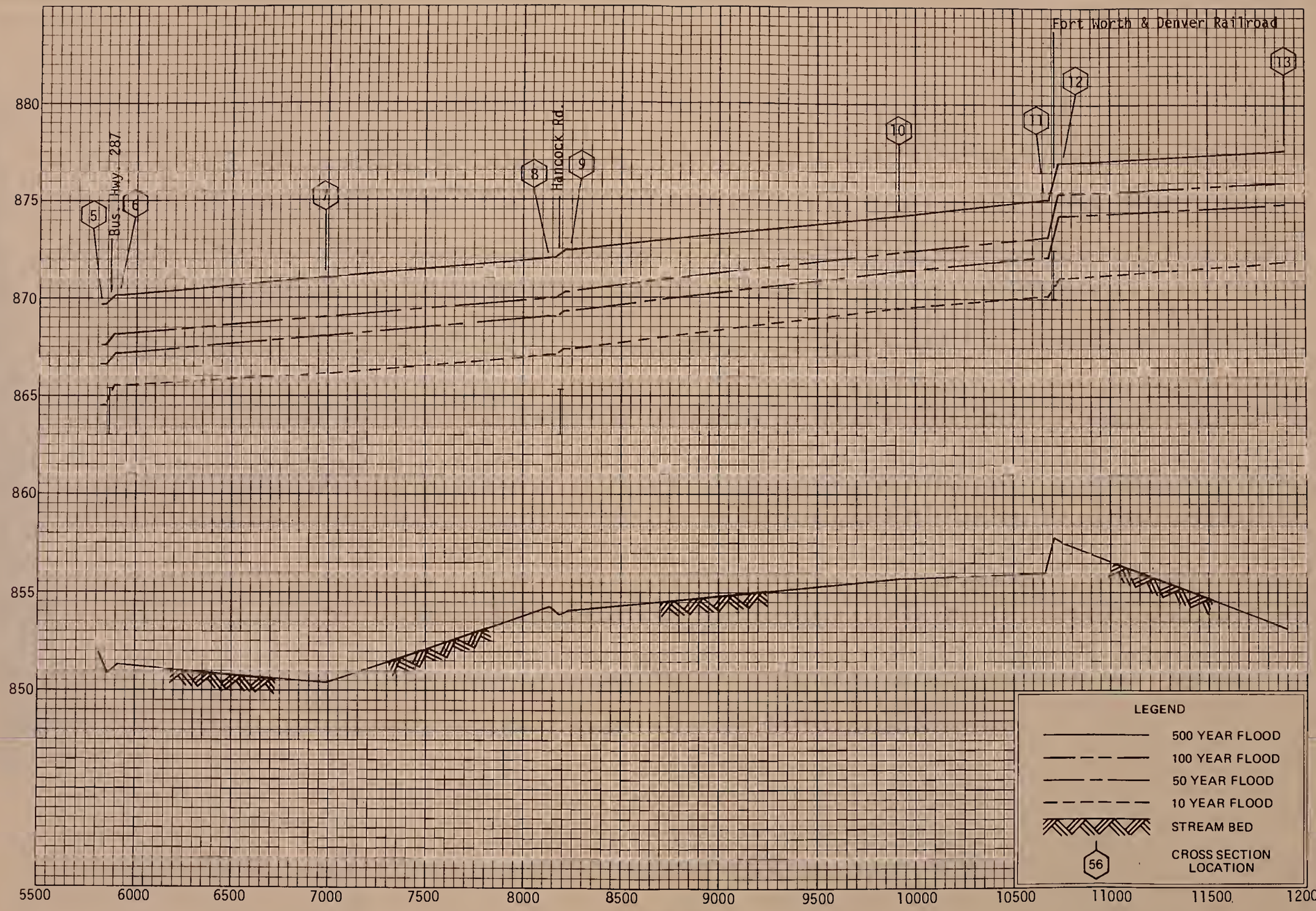
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
Clay County, Texas

WATER SURFACE PROFILES

DRY FORK OF THE LITTLE WICHITA RIVER

SHEET 2 OF 4

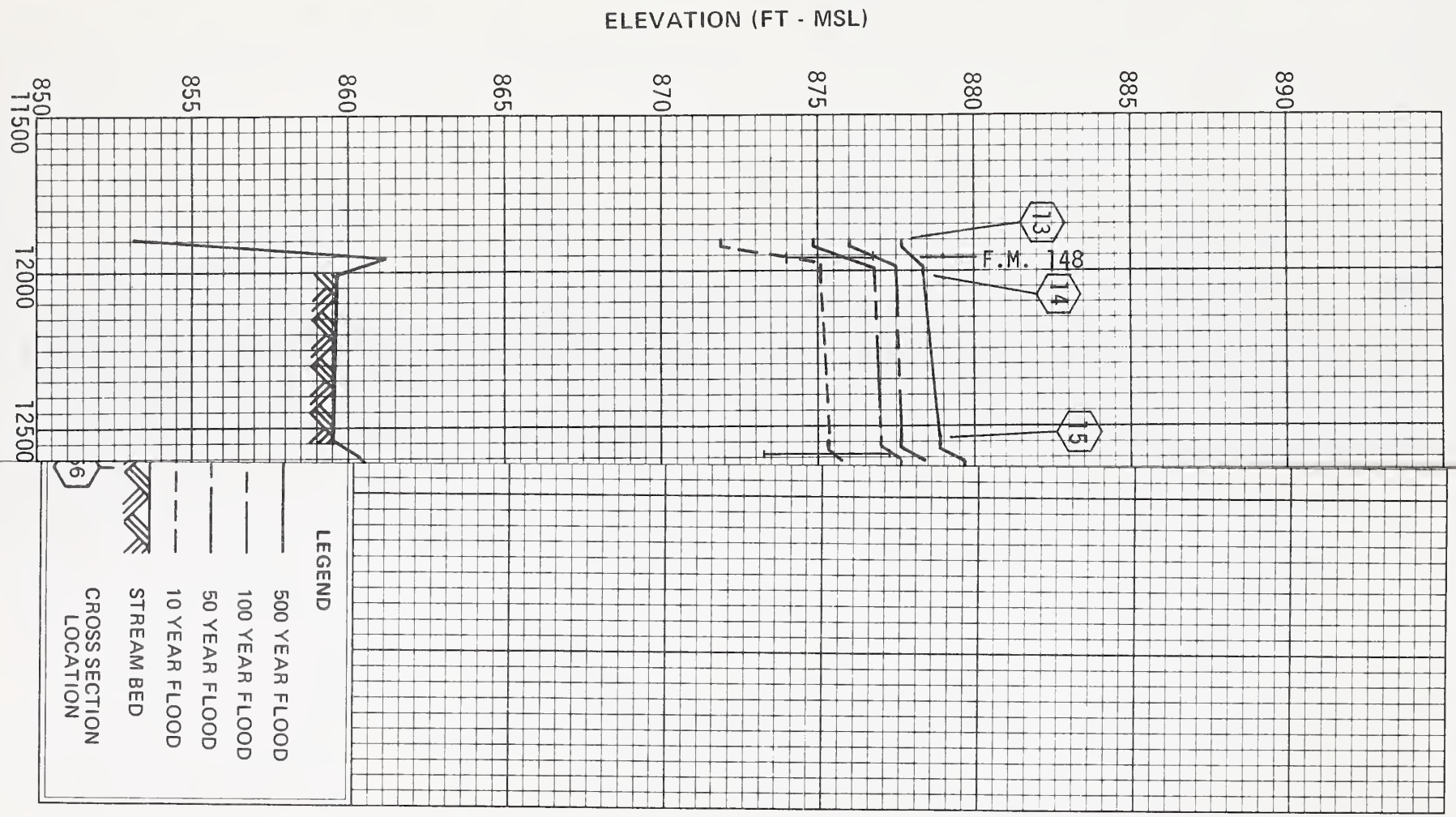


WATER SURFACE PROFILES

DRY FORK OF THE LITTLE WICHITA RIVER

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
Clay County, Texas

SHEET 2 OF 4



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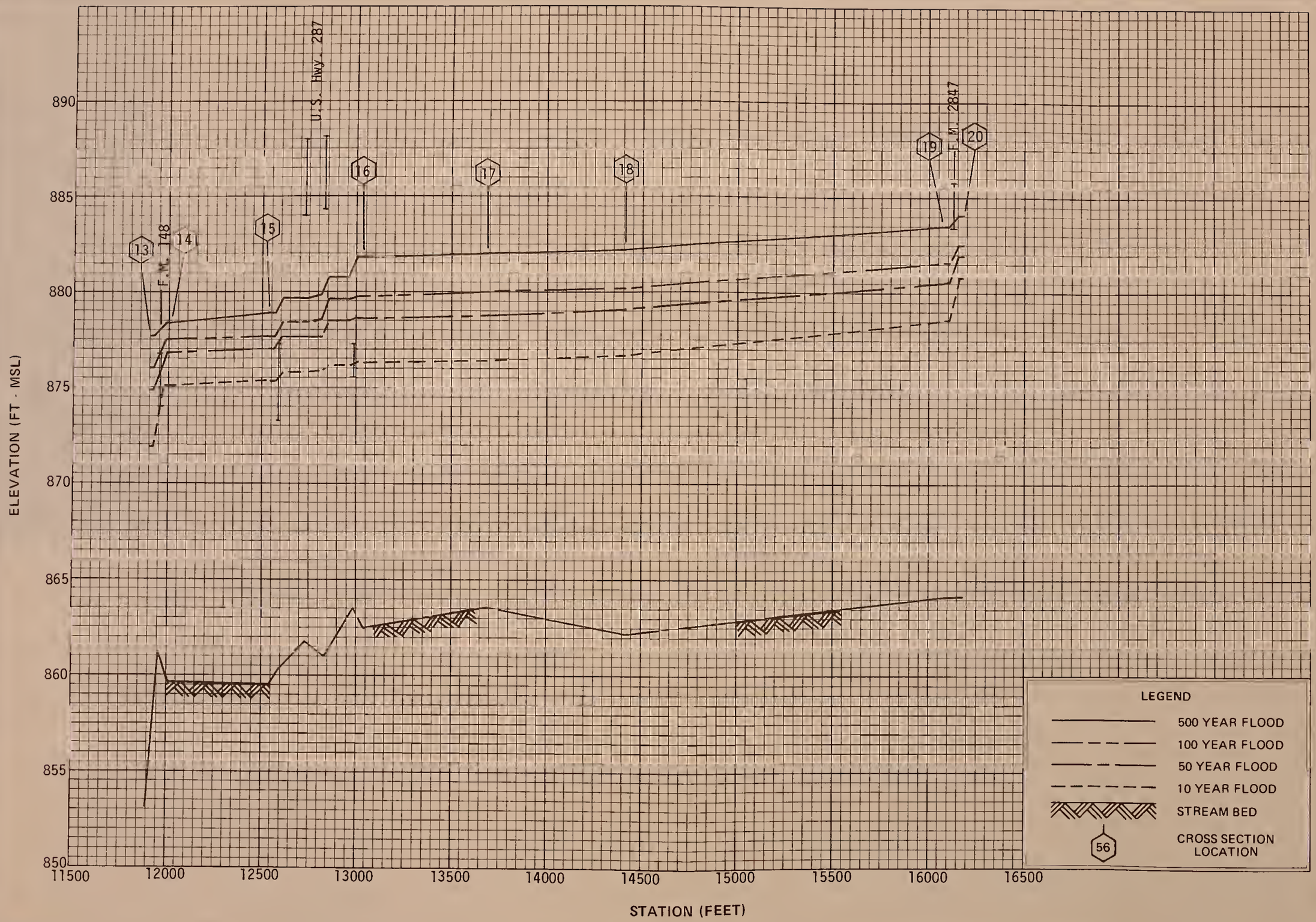
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
Clay County, Texas

WATER SURFACE PROFILES

DRY FORK OF THE LITTLE WICHITA RIVER

SHEET 3 OF 4

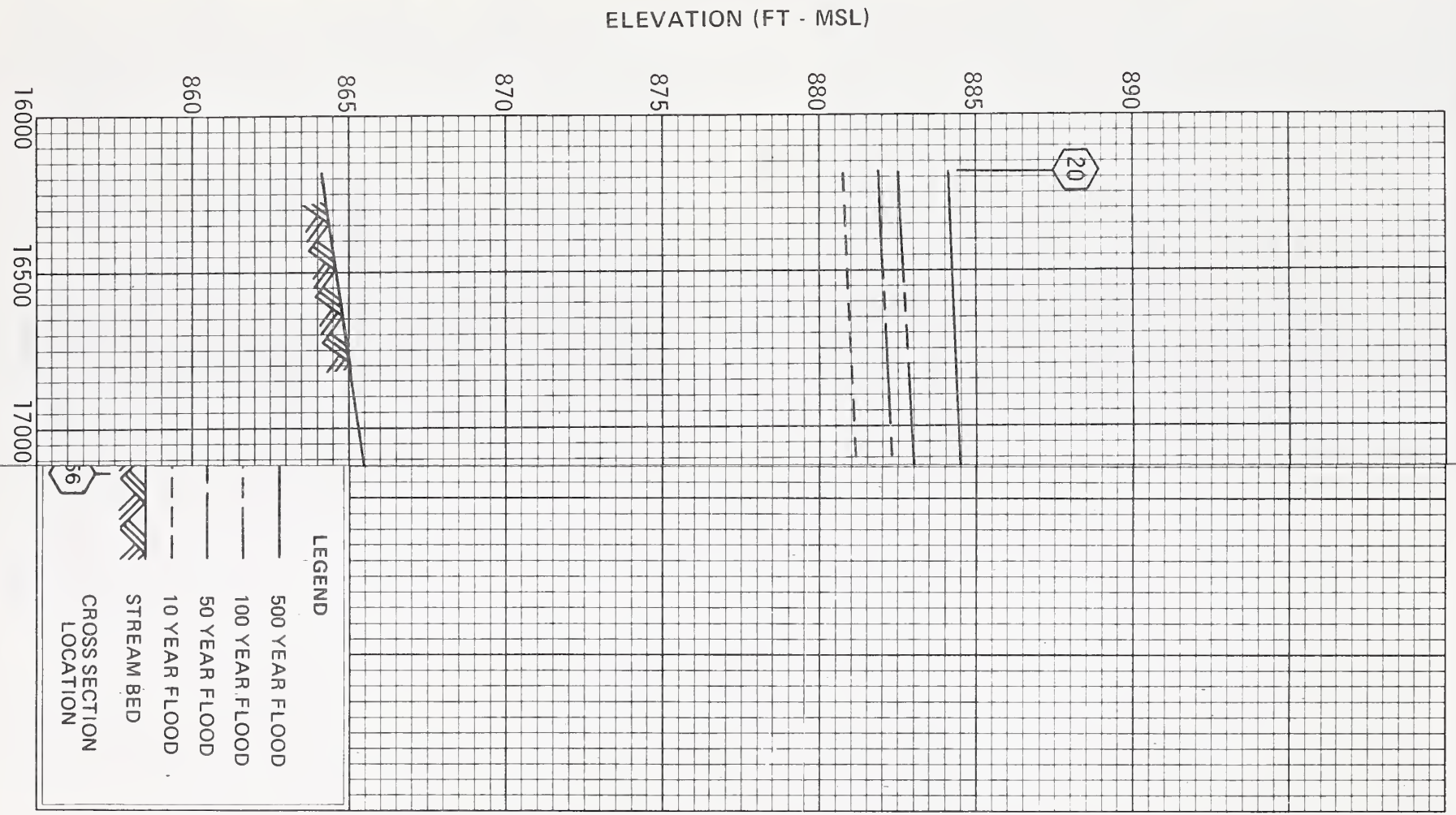


WATER SURFACE PROFILES

DRY FORK OF THE LITTLE WICHITA RIVER

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
Clay County, Texas

SHEET 3 OF 4



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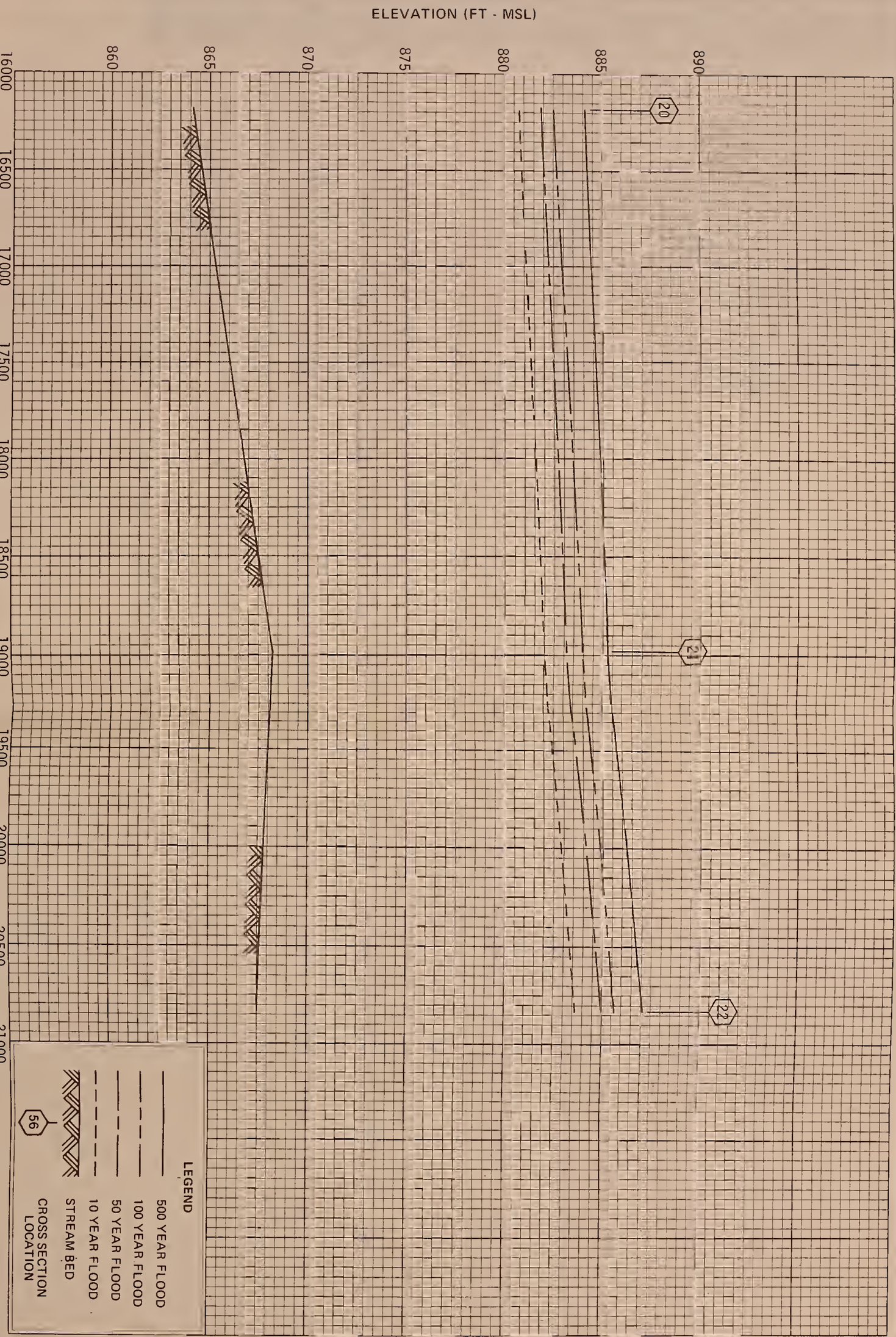
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
Clay County, Texas

WATER SURFACE PROFILES

DRY FORK OF THE LITTLE WICHITA RIVER

SHEET 4 OF 4



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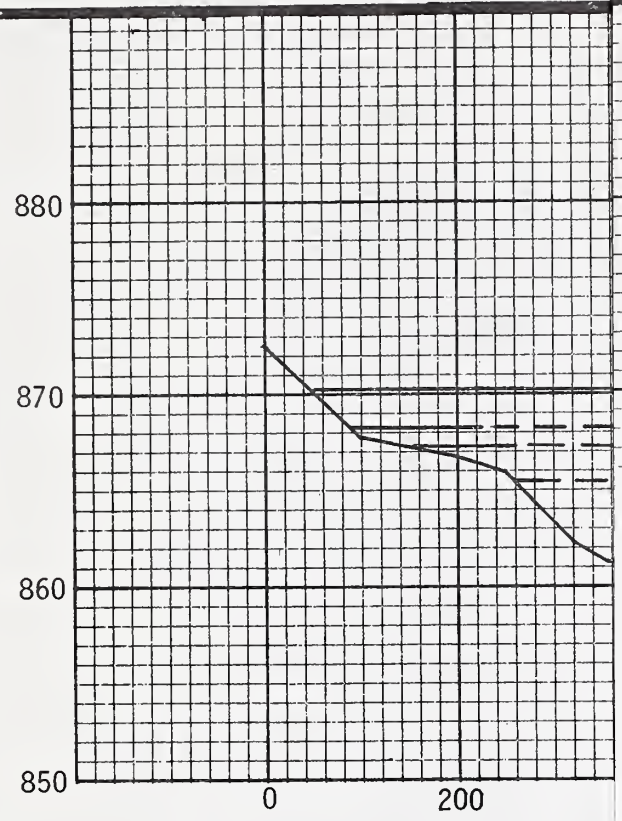
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
Clay County, Texas

WATER SURFACE PROFILES

DRY FORK OF THE LITTLE WICHITA RIVER

SHEET 4 OF 4



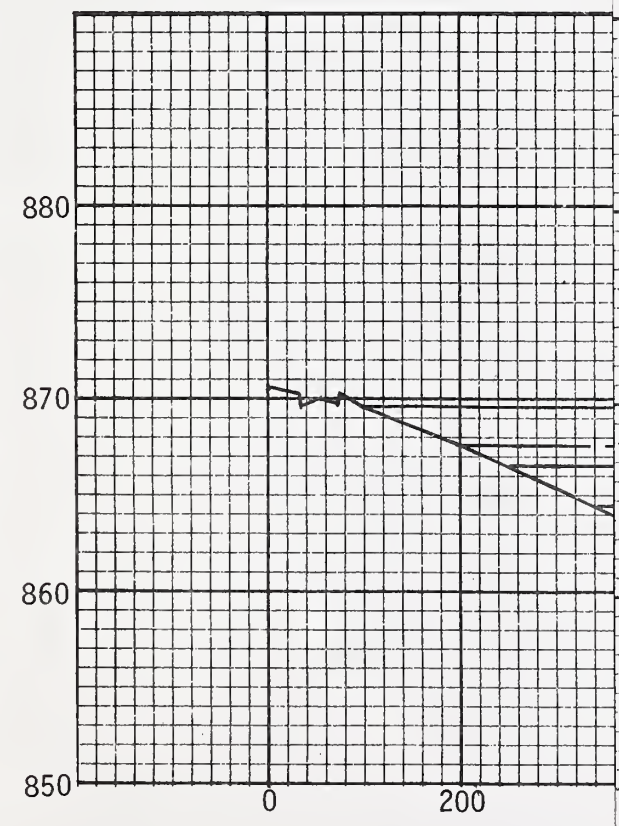
LEGEND

500 YEAR FLOOD

100 YEAR FLOOD

50 YEAR FLOOD

10 YEAR FLOOD



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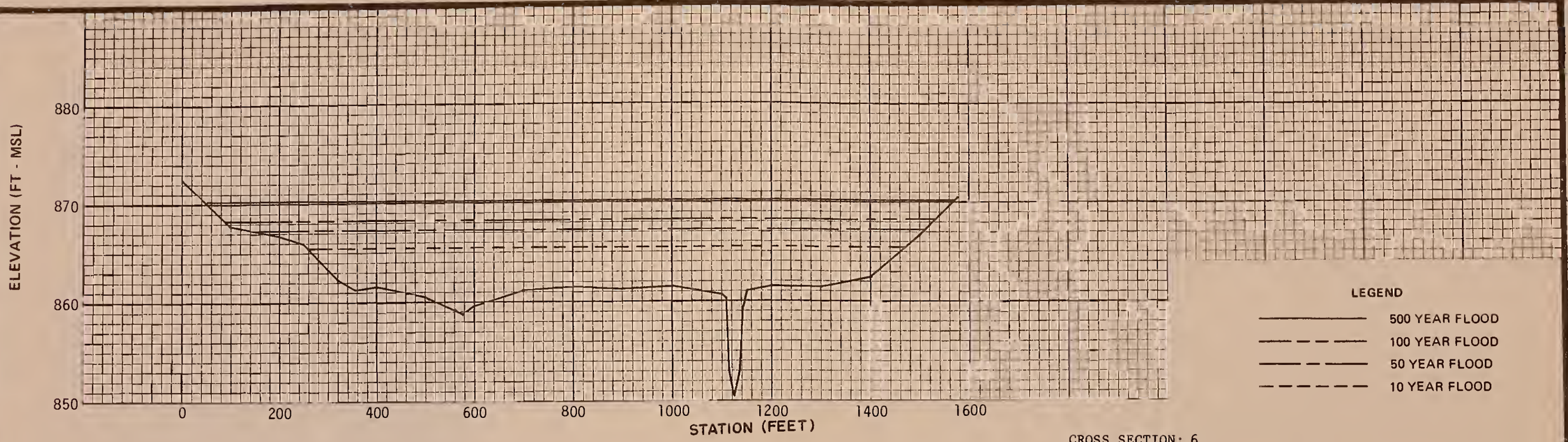
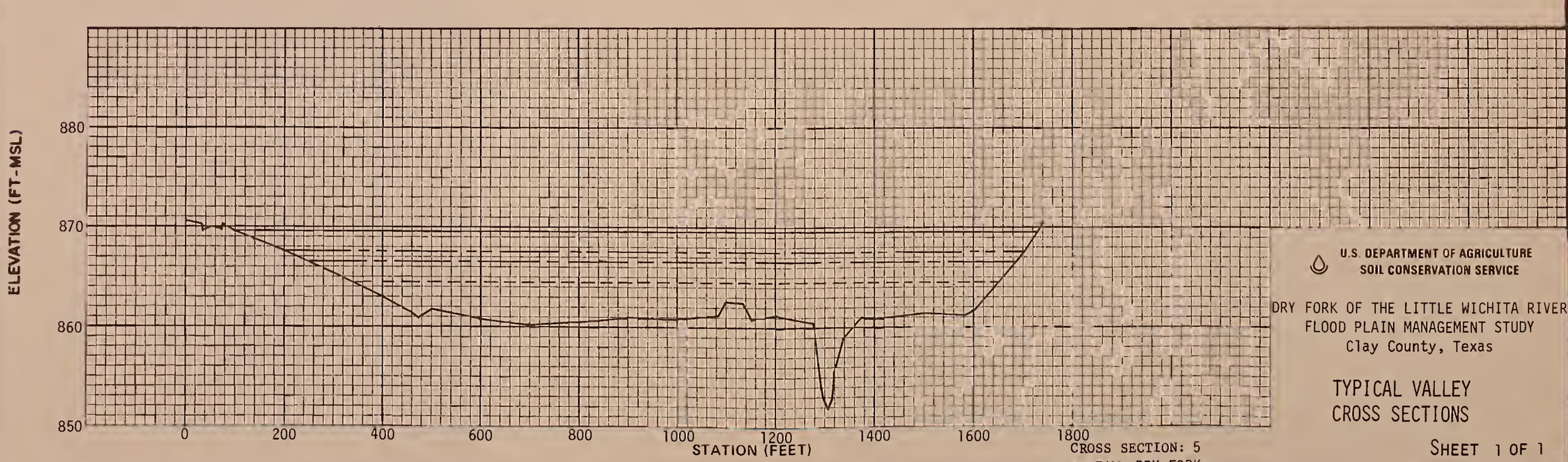
DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
Clay County, Texas

TYPICAL VALLEY
CROSS SECTIONS

SHEET 1 OF 1



CROSS SECTION: 6
STREAM: DRY FORK



CROSS SECTION: 5
STREAM: DRY FORK

U.S. DEPARTMENT OF AGRICULTURE
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DRY FORK OF THE LITTLE WICHITA RIVER
FLOOD PLAIN MANAGEMENT STUDY
Clay County, Texas

TYPICAL VALLEY CROSS SECTIONS

SHEET 1 OF 1

TABLE 1

DRY FORK OF THE LITTLE WICHITA RIVER

ELEVATION AND DISCHARGE TABULATIONS

Cross Section Number	PRESENT CONDITIONS											
	10-YEAR FREQUENCY			50-YEAR FREQUENCY			100-YEAR FREQUENCY			500-YEAR FREQUENCY		
	Discharge CFS	Elevation M.S.L. Feet	Flood Plain Width Feet	Discharge CFS	Elevation M.S.L. Feet	Flood Plain Width Feet	Discharge CFS	Elevation M.S.L. Feet	Flood Plain Width Feet	Discharge CFS	Elevation M.S.L. Feet	Flood Plain Width Feet
1	6,825	856.5	1,615	13,127	858.6	1,745	16,976	859.5	1,780	25,989	861.4	1,890
2	6,825	857.3	1,455	13,127	860.0	1,570	16,976	861.0	1,615	25,989	862.9	1,720
3	6,338	860.4	1,075	12,111	862.8	1,185	15,652	863.9	1,246	23,803	865.9	1,329
4	6,369	862.7	1,410	12,155	864.9	1,530	15,709	866.0	1,745	23,883	868.0	1,940
5	6,395	864.5	1,315	12,172	866.6	1,440	15,732	867.6	1,490	23,923	869.7	1,635
6	6,395	865.5	1,220	12,172	867.2	1,380	15,732	868.2	1,440	23,923	870.2	1,525
7	6,422	866.2	1,310	12,200	868.1	1,415	15,766	869.0	1,455	23,970	871.1	1,575
8	6,455	867.]	1,390	12,242	869.0	1,480	15,816	870.0	1,565	24,040	872.0	1,615
9	6,455	867.4	1,610	12,242	869.3	1,745	15,816	870.3	1,765	24,040	872.4	1,840
10	6,491	869.5	1,265	12,311	871.4	1,395	15,904	872.4	1,470	24,166	874.3	1,690
11	6,498	870.2	1,415	12,326	872.2	1,715	15,924	873.2	2,040	24,196	875.1	2,200
12	6,498	871.1	1,750	12,326	874.3	1,960	15,924	875.4	1,985	24,196	877.0	2,025
13	6,539	871.9	1,990	12,437	874.9	2,090	16,069	876.0	2,115	24,364	877.7	2,150
14	6,539	875.1	1,810	12,437	876.8	1,825	16,069	877.5	1,828	24,364	878.4	1,815
15	6,604	875.3	1,920	12,512	877.0	1,975	16,149	877.7	1,990	24,445	878.9	2,597
16	6,604	876.3	2,705	12,512	878.7	2,950	16,149	879.8	3,000	24,445	881.8	3,085
17	6,728	876.4	2,485	12,710	878.8	2,580	16,380	880.0	2,630	24,714	882.0	2,650
18	6,880	876.7	1,840	12,937	879.1	2,005	16,636	880.2	2,045	25,009	882.2	2,120
19	7,034	878.6	1,590	13,192	880.6	1,780	16,937	881.6	1,873	25,383	883.5	2,225
20	7,034	880.8	1,810	13,192	881.9	1,895	16,937	882.5	2,050	25,383	884.1	2,300
21	7,224	882.0	2,720	13,395	883.2	2,835	17,130	883.9	2,865	25,774	885.3	2,950
22	7,270	883.7	2,025	13,454	885.0	2,110	17,190	885.7	2,145	25,608	887.1	2,230

TABLE 2

BENCH MARK DESCRIPTIONS AND ELEVATIONS

FLOOD PLAIN MANAGEMENT STUDY

DRY FORK OF THE LITTLE WICHITA RIVER

Clay County, Texas

Flood Hazard Area Sheet Number	RM Name	Elevation (Ft. msl)	Description
1	RM DF-7	862.77	A chiseled square on the curb of the southwest corner of bridge of Dry Fork of the Little Wichita River, 600 feet east of old railroad.
1	RM DF-7A	864.56	On the head of a 60d nail in the southeast root of a 48-inch diameter post oak tree, 100 feet north of Highway 82, 50 feet east of old railroad.
1	RM DF-9	866.07	A chiseled square on northeast end of bridge over Dry Fork, Business 287.
1	RM VS-8	870.06	On the head of a 60d nail in the west base of a power pole on the west side of S. Hancock, 1,500 feet south of Omega.
3	RM S-1	882.40	Top of bend in 60d nail in south side of brace post, 1,900 feet west of F.M. 148, south side of F.M. 2847, 70 feet north of stock tank.
3	RM S-6	878.40	A 60d bent nail in 14-inch diameter ash tree. Tree is on south bank of creek at Sta. 32+85E. Nail is 0.5 foot above ground on southwest side of leaning tree.